The Ecologic Relations of the Photogenic Function among Insects.

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Among the noumerous interesting problems connected with the emmission of light by living organisms are those which center around the usefulness of the light-producing power to the organisms themselves. For the great majority of luminous creatures no definite conclusions as to the utility of the luminosity can be reached, although there are good reasons for considering that it is probably defensive, alluring etc., in function, in various groups.

In at least two phyla, however, it has been possible to arive at a definite explanation of the usefulness of the photogenic function during the life of the organisms:

Among the Annelids, Galloway (3) and Galloway and Welch (4) have shown that the luminosity serves as a mating adaptation in *Odontosyllis enopla.* Recently Potts (17) has called attention to the similar habits of *Odontosyllis phosphorea*, in which the luminosity appears to play a more subordinate part in mating. Lund (8) has also made observations on marine annelids.

It is among the insects, however, that we have the most definite cases of the application of the light-producing power to lives of the organisms. Among the Coleoptera there is the family Lampyridae, in which a very large number of the species possess the photogenic function. The surmises as to the usefulness of this function to these insects have embraced the protective, alluring and reproductive ideas, but it is now known that in at least certain of the genera of Lampyrids, the photogenic function serves, as in the Odontosyllids mentioned above, as a mating adaptation. Among the older writers, Spallanzani (18) and Rennie (19) both called attention to the attraction between the sexes apparently as the result of the luminosity, though the latter writer is inclined to interpret his observations as rather opposing the theory of the significance of the function for mating. Lubbock (7) notes a similar instance.

The first conclusive observations were made by Osten-Sacken (16), on the American species *Photinus pyralis.* Osten-Sacken found that the females of this species remained clinging to grass, leaves, etc., while the males flew above them, flashing at intervals. When the flash of a male was seen by a female, she answered by flashing, and upon the male seeing this answering flash, he alighted near the female, finally locating her definitely through subsequent flashes, and mating with her.

Next chronologically were the observations of Emery (2) upon *Luciola italia.* Emery watched the actions of the sexes in this species, and concluded that they depended upon the use of the luminous power for meeting and mating. He then tried a number of experiments, and found that females enclosed in a perforated opake box did not attract males, while those enclosed in glass vials did, thus excluding the effect of odors.

Osten-Sacken's paper was not well known until recently, and his observations were accordingly fequently overlooked, he records, however, what is probably the first definite establishment of the ecologic relations of the photogenic function in any species. Not knowing of

Osten-Sacken's work at the time, McDermott (11) recorded observations on the mating of *Photinus pyralis* very similar to those of Osten-Sacken. He found further that it was possible to cause light-emission from either sex by the proper operation of a small electric lamp in imitation of the opposit sex, or from the females by flashes of light from other sources, such as a match. A slight pause was found to intervene between the flash of the male and the answering flash of the female. McDermott (11, 12) extended his observations to *Photinus consanguineus*, *P. scintillans*, *P. marginellus*, *P. castus* and *Lecontea lucifera*.

In *Photinus consanguineus* the flash of the male, instead of being single, is composed of two distinct coruscations, while that of the female is a single flash like that of the female *pyralis*; the female *consanguineus* would answer only to a double flash. In *P. scintillans* and *P. castus*, both smaller species than *P. pyralis*, the flashes of the male and female are both single, and of rather shorter duration than that of *pyralis;* the ranges of the two species appear to overlap, though they were not found together. *P. castus* and *P. marginellus* were found in the same habitat; the manner of light-emission of the males of the two species differs only slightly, that of *marginellus* being a trifle sharper. The females, however, appear to distinguish between them readily, and the answering flashes of the two females are quite different. The flash of the female *castus* is a single flash, as described above, following the flash of the male by a very short pause; that of the female *marginellus* is a distinctly double flash, the two maxima following each other closely. With the idea of making these differences somewhat clearer, the accompanying diagram has been drawn, in which the abcissae represent time, one second to the centimeter, while the ordinates represent luminous intensity, one centimeter equalling approximately 0.02 candle-power.

Photinus castus was first described by Leconte as a separate species, but was later classed by him as a variety of *marginellus*. On account of the differences in light-emission, McDermott (13) has restored it to the position of a distinct species.

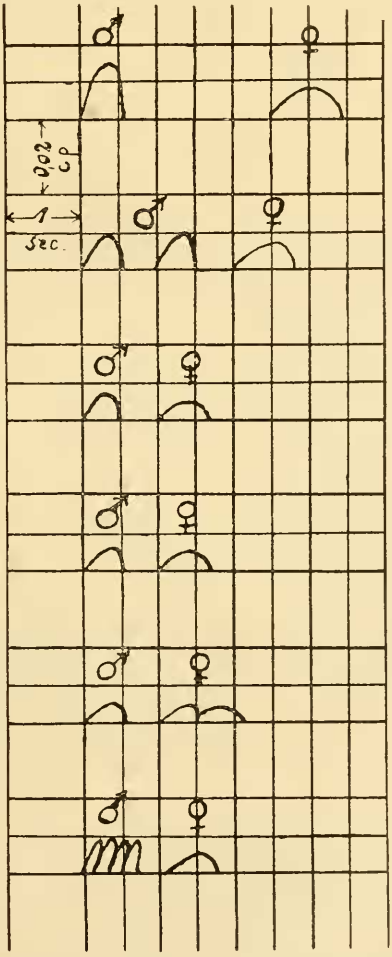
Green (6) has recently described the mating of *Dioptoma adamsii*; In this species the luminous organ of the female is, as usual, ventral, but the luminosity is rendered more effective by curling the abdomen over the dorsal, so as to expose the surface of the luminous apparatus upwards. The abdomen is returned to the normal position upon the approach of the male. In this case, as in *Lampyris noctiluca*, the female is larger and brighter than the male.

The conduct of the *Lampyridae* toward artificial light is of interest. Both McDermott (11, 12) and Mast (10) have shown that the species of *Photinus* may be deceived by small artificial lights operated in imitation of the opposit sex. They are, however, practically unaffected by ordinary continuous lights. The writer has seen a male *Photinus pyralis* fly past an open arc-light, within about 1.25 meter of the arc, without showing the least sign of attraction toward it. On one occasion a decided attraction toward an oil lamp was observed on the part of a male of *Lecontea lucifera*. Lund (8) has observed that the Jamaican species *Photinus pallens* shows a very slight attraction toward ordinary lights. On the other hand, the males of *Lampyris noctiluca* have long been

known to be attracted toward lights. Both sexes of *Photuris pennsylvanica*, a species whose mating has been observed only rarely, and in which the relation of the luminosity to mating is unknown, come to light quite frequently.

Mast (10) has shown that the orientation of the male *Photinus* to the female after her response, is extremely accurate, and takes place after the stimulus has ceased, in entire darkness, thus offering an objection to Loeb's theory of phototropism.

There appear to be two main or general types of expression of the photogenic function among the *Lampyridae*; these are (A), that in which the female emits light in flashes, and only in answer to a male (or to artificial stimulus), typified by *Photinus;* and (B), that in which the female exposes a continuous light until mated, typified by *Lampyris*. In A, the males are usually the more brightly luminous; in B, the females are usually the brighter and frequently apterous, while the males may be nearly or entirely non-luminous. The second type reaches its extreme development in *Phengodes*, e. g., *P. laticollis* [see Barber (1)]. Gorham (5) and Olivier (14) have both called attention to the relations between the development of the photogenic apparatus and that of the eyes, antennae, etc., in the sexes. As a general rule the eyes of the males are larger and their antenae longer than those of the females, the extreme being represented by *Phengodes*.



Some species which in the adult stage are diurnal and have either no luminous apparatus, or organs which are non-functionating, in the larval stage possess organs as highly developed as have the larvae of the brightly luminous species; such are *Rileya (Lucidota) atra*, and it is said, *Ellychnia corrusca*. *Phosphaenus hemipterus* — apterous, diurnal, and faintly luminous in both sexes and in the larva — seems to be quite anomalous, and probably represents a degeneration.

Bogen XX der „Zeitschr. f. wiss. Ins.-Biologie", Druck vom 10. September 1914.

Some interesting speculations as to the phylogenetic relations of the *Lampyridae* and other luminous insects presents themselves here, but we have so little evidence in any direction that even speculation seems hardly justified. Olivier (15) has called attention to the main features in the geographic destribution of the *Lampyridae*. The relatively immense number of species in South America — nearly half of the 1200 described species — is especially interesting and probably significant. The relatively scarcity in Africa is also noteworthy. On the wohle the *Lampyridae* show the same pecularities in dispersal as are found among other creatures; — e. g., the genus *Psilocladus*, whose species are found only in South America and in Japan.

A second interesting group of luminous Coleoptera are the members of the Elaterid genera *Pyrophorus* and *Photophorus*. These two genera are very close, and while little is known as to the habits of *Photophorus*, it is not improbable that it will prove very much like *Pyrophorus*. Lund (8) and others have shown that *Pyrophorus* is strongly attracted to a moving light, and we are probably safe in assuming that in them the luminous power plays the part of an attraction between the sexes. *Photophorus* presents one of those remarkable peculiarities of geographic distribution, occurring as it does in the Fiji and nearby islands, some eight thousand kilometers from its nearest luminous relatives in South America.

Phengodes has already been referred to under the *Lampyridae;* the peculiar structures of these insects, the vast differences between the sexes in the adult stage, etc., has long made them a matter of considerable entomologic interest; with them stands, in this regard, *Dioptoma adamsii*, before referred to. The New Zealand *Bolitophila luminosa* seems to be about the best known of the non-coleopterous luminous insects, and presents the only definitely known instance of proven self-luminosity in the entire order of Diptera.

It it probable that among all the brightly luminous members of the family *Lampyridae*, the luminosity serves as a means whereby the sexes may meet; it also seems very probable that this is the utility of the photogenic function in all luminous Coleoptera, and indeed in all self-luminous insects. Among others luminous forms, — Annelids, fish, crustaceans, etc., — this may sometimes be the ecologic relation of the function, though in particular instances the defensive and other relations may also enter in.

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13. McDermott; Note on *Photinus castus* Leconte; Canad. Entomol., 1912, Vol. 44, p. 312.
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15. Olivier; Distribution géographique des Lampyrides; Compt. Rend. Assn. Fr. Av. Sci., 1910, Sess. 38, pp. 699—701.
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17. Potts; Swarming of *Odontosyllis phosphorea;* Proc. Cambridge Philos. Soc., 1913, Vol. 17, pp. 193—200.
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19. Rennie; Insect Miscellanies; London, 1831.

Kleinere Original-Beiträge.

Ueber einen Schmetterlingszug in Deutsch-Ostafrika.

Am 22. Januar 1914 beobachtete ich in Mittel-Deutsch-Ostafrika einen sehr starken Zug der afrikanischen Pieride *Catopsilia florella* F. Ich befand mich an jenem Tage auf dem Marsch nach dem Uheheland und hatte mein Lager in Kampandizi, einem Ort an der Karawanenstrasse zwischen Kilossa und dem grossen kuaha aufgeschlagen. Am Vormittag jenes Tages war der Himmel stark bedeckt, ohne dass es zum Regnen gekommen wäre. Gegen zwei Uhr mittags drang die Sonne durch das Gewölk, und wenige Minuten später waren die Weisslinge wie aus dem Boden gezaubert da. Zuerst traten sie in fast schneeflockenartigen Schwärmen, die sich über die ganze Breite des mehrere hundert Meter breiten Tales hindehnten, auf, dann, als nach etwa fünf Minuten der Hauptzug beendigt war, folgten sie sich nurmehr noch vereinzelt mit einzelnen Phasen stärkeren Erscheinens. Der Zug hielt fast genau die Richtung Süd-Nord und folgte dabei dem in derselben Richtung streichenden Tal. Die Schmetterlinge hielten sich dicht am Boden und erhoben sich nur einzeln zu Baum- und Häuserhöhe; ihr Zugtrieb schien sehr stark zu sein, da ich nicht einen bemerken konnte, der über eine Blume gegaukelt, nicht einen, der den raschen geradeaus gehenden Flug durch Seitentouren verzögert hätte; der Fang einzelner Exemplare war daher nicht leicht. Der Zug bestand vorwiegend aus den weisslichen ♂♂, die gelblichen, gut erkennbaren ♀♀ waren höchstens zu 1—2 pCt. vertreten. Wenige Minuten nach 2 Uhr mittags nahm der Zug seinen Anfang und war nach ca. 25 Minuten beendet.

Forstassessor Ludwig Schuster (Morogoro, Deutsch-Ostafrika).

***Tephroclystia sinuosaria* Ev.**

Am 11. Juli 1909 erbeutete ich bei Köslin in Pommern ein Exemplar dieser Spannerart, deren Fluggebiet sich nach Staudinger-Rebel über Russland und einen Teil von Asien erstreckt. Das Stück wurde mir durch Güte des Herrn Prof. Dr. Standfuss bestimmt mit dem Bemerken, dass die Art für Deutschland neu sei. Ich dachte zuerst an eine Verschleppung mit der Eisenbahn, obwohl dieselbe fast $^3/_4$ Stunden von dem Fundort entfernt liegt. Im folgenden Jahre (1910) fand ich nun an derselben Stelle ein zweites Exemplar dieser Art, so dass dieselbe als eine in Deutschland, im besonderen bei Köslin, heimische Species anzusehen ist. Vielleicht erklärt sich das Vorkommen an dieser Stelle dadurch, dass Köslin am Fusse des Gollenberges liegt, der zu den Ausläufern des uralisch-baltischen Höhenzuges gerechnet wird.

Dr. Dannenberg (Köslin).

On the affinities of the subfamily Aphelininae.

This subfamily is now classed with the *Eulophidae* (chalcidoid Hymenoptera) but I have so frequently mistaken members of it for encyrtids that it commences to seem doubtful to me whether it should be retained in its present position. I have described several genera of encyrtid Paneostigmini resembling *Aphelininae*